Books

Action des Rayonnements de Grande Energie sur les Solides. By Y. Cauchois, J. Friedel, N. F. Mott, A. Herpin, J. Blin, P. Aigrain, H. Curien, G. Mayer, P. Perio, M. Tournarie, M. Gance, M. Lambert, A. Giunier, A. Chapiro, J. Uebersfeld. 139 pp. Gauthier-Villars, Paris, France, 1956. Clothbound 2.100 fr.; paperbound 1.800 fr. *Reviewed by R. Smoluchowski, Carnegie Institute of Technology.*

It seems that our present vogue of new series of books, monographs, and reviews of various degree of specialization and sophistication is finding its counterpart on the old continent. The present small volume is the first of a new series of monographs in physical chemistry edited by Miss Yvette Cauchois, professor at the Sorbonne. It is an outgrowth of a conference held in Paris in spring of 1955 under the same general title. It should be most welcome among all those who are interested in irradiation effects since it provides a very convenient and easy way of getting informed about the present thought and deed in France in this domain. From his own recent experience the present reviewer is fully aware of the great need for furthering such exchange of information between the two countries.

A brief introduction to the field of irradiation effects in solids by Y. Cauchois is followed by a survey of crystalline defects by J. Friedel. This excellent chapter, and also the longest one, treats in some detail the forthcoming book on dislocations by the same author. In a two-page brief note N. F. Mott discusses the possible interpretations of the very large number of atomic jumps necessary for the annealing of defects including the theory based on "crowdions". In a longer chapter A. Herpin gives a very clear summary of the theories of production of defects by irradiation, including the slowing down of fast particles by ionization, formation of displaced atoms by neutron collisions, etc. This is followed by a chapter by J. Blin describing the effects observed in metals, in particular the changes of resistivity and their annealing. A chapter by P. Aigrain surveys the irradiation effects in semiconductors, the threshold energy measurements, the annealing spectra, etc. H. Curien gives first a brief introduction to the thermal conductivity of dielectrics and indicates the typical effects observed in quartz, sapphire, and diamond. The effects produced in graphite, quartz, and lithium fluoride are described by G. Mayer, much of this being his original work. Also many original results pertaining to the x-ray study of the effects produced by irradiation are reported by G. Perio, M. Tournarie, and Miss M. Gance. They treat in particular detail the changes of lattice constant of LiF. Directly connected with this is the following paper by Miss M. Lambert and A. Guinier which concerns small angle x-ray scattering and curious streaks in x-ray diffraction patterns observed in irradiated LiF. This work is quite recent and not published elsewhere. In fact Guinier's experiments have been initiated and performed during the conference itself. An outline of the vast field of irradiation effects on polymers is given by A. Chapiro and the booklet closes with a survey of the paramagnetic resonance studies of lattice defects by J. Uebersfeld. Thus both for the beginner and for the advanced research man the booklet brings together much valuable material and basic information.

The reviewer cannot resist the opportunity to express his appreciation for the very kind hospitality and friendliness accorded him during his stay in France by his friends at the Sorbonne and at Saclay, nearly all of them being the co-authors of the booklet here reviewed.

Marian Smoluchowski. By Armin Teske. 278 pp. Polish State Scientific Publishing House, Krakow, Poland, 1955. About $6.00. *Reviewed by Mark Kac, Cornell University.*

Living in an era when almost every day brings news of a discovery of a new "elementary" particle it is hard to realize that it was not much more than fifty years ago that the very existence of atoms and molecules was the subject of a spirited and highly controversial debate.

Physics is by nature a rather conservative science. It tends to discourage speculations for the sake of speculating and it undertakes a revision of its principles with great reluctance and only when forced into it by a compelling necessity in a form of a major difficulty or paradox.

The criticism against the great work of Boltzmann was precisely that, apart from logical difficulties, it was pure speculation, contributing little to our picture of the world. A reviewer of Boltzmann's *Vorlesungen über Gastheorie* went even farther, writing in 1898: "The kinetic theory, as is well known, is as wrong as different mechanistic theories of gravitation. In particular, it envisages quite erroneously the principle of conservation of energy. If however someone wants to get acquainted with it let him by all means read Boltzmann." Ten years later, in 1908, the strongest opponent of atoms and kinetic theory, the famous Ostwald, capitulated and the discontinuous nature of matter became firmly established.

What happened during the ten years between the appearance of the second volume of Boltzmann's great book and the capitulation of proponents of the traditional thermodynamics is an exciting chapter not only in the history of physics but in the general history of scientific thought.

The phenomenon which finally raised the atoms from the realm of speculation into physical reality and lowered the Second Law of Thermodynamics from the pedestal of a law of nature to the level of a useful approximation was an erratic motion of small particles suspended in liquids already observed by an English botanist Brown in 1827.

The two scientists who almost simultaneously and quite independently (using, in fact, wholly different methods) provided us with a theory of this remarkable phenomenon were Albert Einstein and Marian Smoluchowski.

Smoluchowski died in 1917 of dysentery at the age of forty-five at the height of a brilliant and remarkable career, and in his death physics lost, to quote from Einstein's obituary, "one of the most penetrating ('einer der feinsinnigsten') modern theoreticians".

We are now offered the first complete biography of Marian Smoluchowski and it is a great pity that because of the language the book will be relatively inaccessible.

For it is an excellent biography and the author has succeeded remarkably well in giving us both a living portrait of a great man and a popular summary of his scientific achievements.

He has also managed to convey (mostly by quotations from letters) the general atmosphere of the times and gives us many lively glimpses of famous contemporaries (Einstein, Boltzmann, the Ehrenfests etc.).

To attempt a summary of a biography would be to reduce it to a nearly meaningless succession of dates and facts. It would be beyond the ability of the reviewer to convey to the modern American reader the true impression of the world into which Smoluchowski was born in 1872 in Vienna. It would be equally impossible to reproject the charm of the man or to explain how in him there came to blend the Polish cultural background with the best in western civilization and upbringing. Fascinating as the reviewer found the purely biographical parts of the book it is with the chapters dealing with Smoluchowski's scientific activity that this review must be primarily concerned.

These chapters are excellent both as a popular presentation of a difficult subject and as history of science. We find in these chapters numerous excerpts from Smoluchowski's correspondence with contemporary scientists bringing into the narrative a sense of lively immediacy.

The biographer discusses all of Smoluchowski's scientific works but treats in great detail and with noteworthy expository skill those contributions which are of truly lasting significance and which concern the phenomena of fluctuations. Fluctuations are deviations from the average or normal. Were it not for the atomistic structure of matter fluctuations would not exist. As it is they are extremely small and at first (1903) Smoluchowski was skeptical as to whether they could be actually observed.

Only four years later Smoluchowski writes "All of us have observed them [fluctuations of density] on innumerable occasions while admiring the blueness of the sky". For Smoluchowski has just demonstrated in a classical paper devoted mainly to a related phenomenon of the so-called "critical opalescence" that density fluctuations in the atmosphere are responsible for the scattering of light resulting in the blueness of the sky.

Were we to judge Smoluchowski on the basis of his technical achievements, his work on Brownian motion, critical opalescence, blueness of the sky, and colloidal suspensions would certainly put him among the leading physicists of his day.

But what made him a great physicist was that he recognized the profound bearing of his theory of fluctuations on the question of validity of the Second Law of Thermodynamics.

In a series of papers which should forever serve as models of expository skill and elegance, Smoluchowski subjected the Second Law to a penetrating analysis and emerged with a new, now universally accepted, formulation based on probability.

All this is admirably told in the biography and it is gratifying to have such a lucid record of one of the most important developments in physics.

It is almost forty years since Marian Smoluchowski died. His life and work belong to a period which to many of us seems remote because both the world and the science of physics have changed so much in the meantime. And yet the pleasure (and profit!) the reviewer derived from reading this little volume makes him believe that there is a great deal to be gained by a journey to this "remote" past to get really acquainted with the people who have had such a profound and deeprooted influence on our thinking that some of us may have forgotten how much we owe them.

The Scientific Revolution 1500–1800: The Formation of the Modern Scientific Attitude. By A. R. Hall. 390 pp. The Beacon Press, Boston, Mass., 1956. Paperbound $1.75. *Reviewed by J. C. Polkinghorne, University of Edinburgh.*

The character of modern science was formed in the period 1500–1800. Although our knowledge has increased manyfold in the succeeding century and a half there has been no essential change in method or purpose.

We are all familiar with the great apostolic succession of Copernicus, Galileo, Kepler, and Newton. These years also saw the development of chemistry in the hands of Boyle and Lavoisier and the development of systematics by the natural historians, culminating in Linnaeus. Dr. Hall admirably achieves his purpose of presenting not merely the facts but also an analysis of how this great revolution of ideas came about.

There are two popular and facile explanations of the scientific revolution. One is the economic theory, especially beloved of Marxists, which sees in the expansion of technology the spur to all achievement in pure science. The second, and more subtle, lays stress on the "new philosophy" of induction and experiment formulated by Francis Bacon. Both contain elements of truth but are inadequate as complete explanations. This book shows most clearly the part that has been played by